A BASIS FOR REGIONAL AGRICULTURAL ADJUSTMENTS IN OHIO

by

The Committee on Regional Agricultural Adjustments
of
The Ohio Agricultural Experiment Station
and
The Ohio State University.

Rural Economics
Mimeograph Bulletin #83

Columbus, Ohio
September, 1935

PREFACE

THE purpose of the study was to devise a method of determining desirable changes in the crop and livestock system of the state, and to estimate the effect of these changes upon the agricultural income.

The basic assumption was that the system proposed should be one which would maintain the productivity of the soil at a profitable level over a long period of years. Having calculated the changes in the cropping system necessary to do this, the effect of these changes upon the livestock system and upon income was then computed. Interesting comparisons can be made between the results secured and the adjustments proposed by the Agricultural Adjustment Administration.

Cooperating in this study were the Departments of Agronomy, Animal Husbandry, Agricultural Engineering and Rural Economics. In cooperation with the United States Department of Agriculture similar studies were made in every state during the summer of 1935. The correlation of all state data on a national basis is now in progress.

Division of the State Into Agricultural Areas

The first step was to divide the state into areas. In making this division, five sources of data were primarily used: (1) a generalized soil map of the state, (2) an erosion map of the state, (3) census data, (4) a previous type of farming study, and (5) rotations as shown on the corn-hog contracts.

Through the county agricultural agents' offices data were received from 40 corn-hog contracts in each township, giving the rotation followed on the contracted acreage. A check showed that this gave very nearly the same distribution of crop acreage on a county basis as that shown by the census. In addition to giving percentage distribution of harvested crops by townships, the information also enabled us to compute the per cent of the rotated area in rotated pasture. Area boundaries were run by township lines. Fifteen areas were designated. Further subdivision of most of these areas will be required in developing the details of application of the recommendations for adjustments.

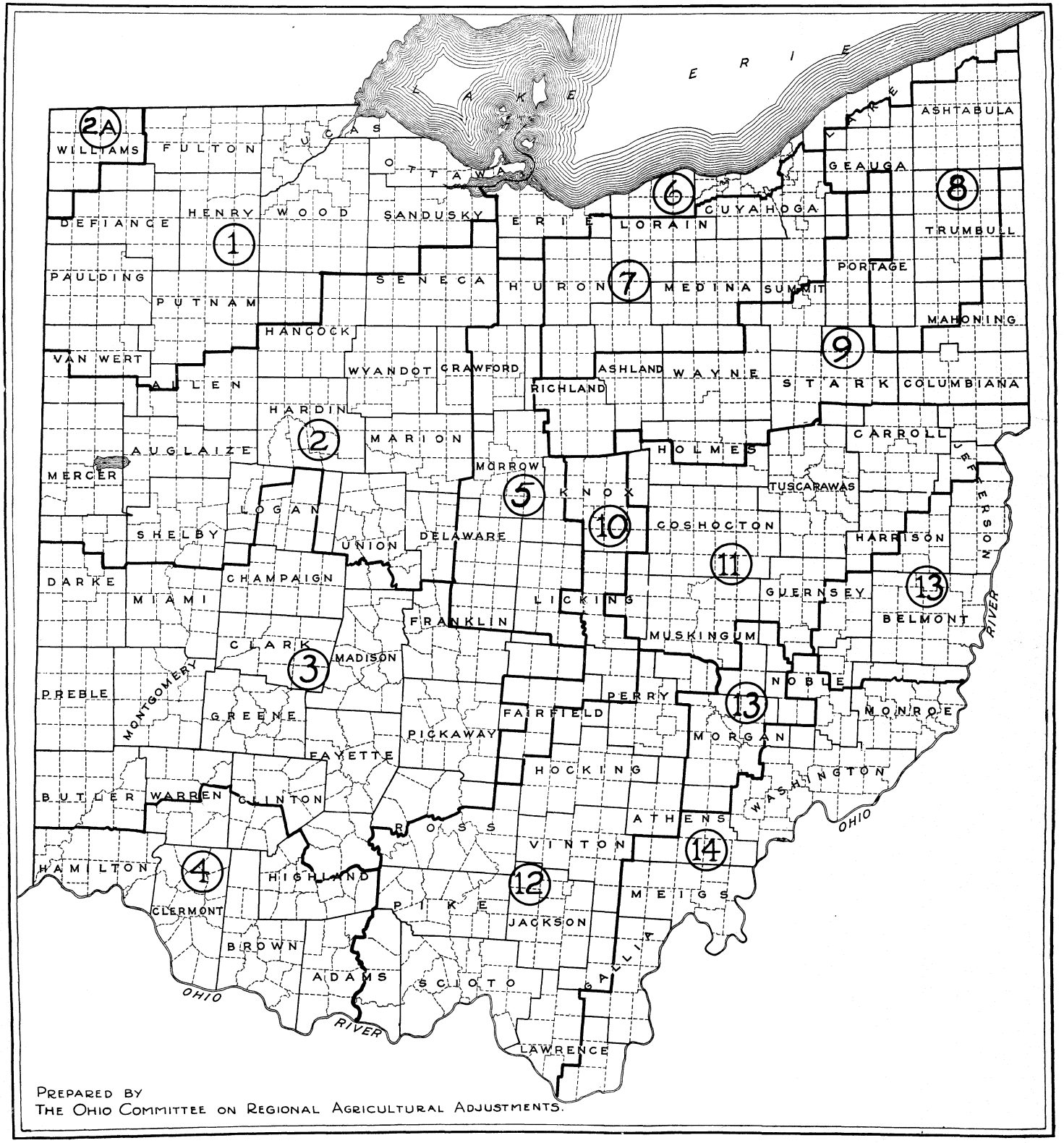
These fifteen areas are, strictly speaking, not type-of-farming areas but areas in which soils, major cropping systems, and apparent problems of adjustment are similar. Large centers of population account for difference in livestock systems within different parts of the same area. Thus a market milk producing area surrounds the city of Columbus, cutting across Areas 2, 3 and 5. Another dairy center is found in the Miami Valley in Area 3, an area otherwise specializing in hog production.

Centers of beef cattle and lamb feeding are found in Areas 1, 2, 3, 5 and 9, but these practices are not general throughout these areas. Centers of specialized crop production such as canning tomatoes in Wood county, onions in Hardin county, tobacco in the western part of Area 3, corn in the Scioto Valley in Area 12 are common. Thus it may be seen that any attempt to divide the state into areas where the type of farming is similar throughout would result in an unwieldy number of areas.

Table 1.--Some Characteristics of Ohio Agriculture, by Agricultural Areas, 1930 Census

	Area 1	Area 2	Area 2a	Area 3	Area 4	Area 5	Area 6	Area 7	Area 8	Area 9	Area 10	Area 11	Area 12	Area 13	Area 14	Total
Percent of land in farms	88.1	91.3	95.8	91.2	83.2	88.1	56.8	71.1	67.6	76.6	90.7	81.7	66.0	84.1	85.4	82.5
Average size of farms	94.9	104.1	98.0	104.9	87.9	100.2	59.1	91.9	87.8	84.5	99.8	109.2	114.0	103.5	92.1	98.1
Percent of farm land in-																
Crop land	73.8	65.0	61.4	62.3	43.6	53.6	65.9	54.6	44.1	54.7	47.5	36.2	30.5	30.3	28.0	52.4
Rotation pasture	5.8	7.3	5.1	12.8	10.2	3.5	2.5	2.7	.2	2.1	7.6	2.1	2.0	.5	0	5.6
Permanent pasture -																
Woods pasture	7.6	8.0	12.7	6.2	6.5	9.6	6.5	12.3	16.4	8.9	5.4	6.9	13.3	7.7	10.5	8.6
Other perm't pasture	6.5	13.4	13.9	12.4	28.9	26.5	13.6	21.3	30.2	22.4	29.4	39.2	30.6	51.3	45.1	23.2
Woods not pastured	1.4	2.0	1.9	1.4	3.8	2.1	3.6	3.3	4.0	4.1	4.7	7.7	15.8	4.3	7.7	4.3
Other land in farms	4.9	4.3	5.0	4.9	7.0	4.7	7.9	5.8	5.1	7.8	5.4	7.9	7.8	5.9	8.7	6.0
Percent of rotated area in -																
Corn	32.2	32.3	24.8	37.0	36.6	30.4	20.9	22.7	19.9	22.0	29.7	21.9	38.8	22.8	30.0	31.4
Other intertilled crops	2.4	1.0	.8	2.3	4.6	1.2	10.6	5.4	3.2	3.6	.9	1.3	3.1	2.0	4.8	2.4
Hay	16.7	21.7	28.3	12.2	18.9	30.9	27.6	32.2	47.7	32.0	26.0	42.7	29.9	55.6	49.5	23.7
Rotation pasture	7.8	10.7	8.0	18.0	23.0	6.8	4.9	5.7	.5	4.3	15.0	6.6	7.7	2.1	-	10.8
Wheat	12.5	12.6	13.7	16.5	9.2	15.0	16.5	17.1	5.5	20.5	21.5	15.7	11.3	6.5	8.0	14.1
Oats	23.4	17.8	18.1	11.6	4.3	12.6	15.2	16.4	18.0	16.3	4.5	11.9	5.9	10.7	6.8	14.6
Other grains	2.9	1.9	3.3	1.7	1.8	1.1	2.8	1.6	4.7	1.3	.8	.8	1.7	.5	.9	1.8
Livestock per 100 acres in farms -																
Total cattle	7.0	7.7	7.1	8.1	6.4	8.1	6.4	8.4	9.9	9.0	8.0	6.9	4.0	7.9	6.5	7.5
Milk cows	4.0	4.2	4.4	4.2	4.1	4.7	4.2	5.6	6.5	6.1	3.9	3.5	2.2	3.9	3.2	4.2
Hogs	12.3	15.7	12.0	20.2	7.4	7.8	3.6	3.0	1.3	5.1	9.9	3.5	3.5	2.0	2.0	9.7
Sheep	4.7	14.1	9.7	7.3	4.4	20.1	4.3	8.3	2.7	5.3	23.4	17.0	4.4	21.0	8.5	9.8
Horses	2.8	2.7	2.7	2.9	2.6	2.4	2.5	2.6	2.3	2.7	2.3	1.9	1.7	1.9	1.9	2.4

OHIO AGRICULTURAL AREAS



Prepared by
The Ohio Committee on Regional Agricultural Adjustments.

Description of the Areas

Area 1.

This area, largely of level topography, includes the lake plain region of northwestern Ohio. In general, its soils are among the most productive in the state, although there are some areas of very unproductive sandy soil. Something of the character of the land may be gained from the fact that 80 per cent of the farm area was in crops and rotation pasture in 1929, the highest of any of the areas of the state in this respect. The area might be designated as a cash grain area; for example, 44 per cent of the farm area of Wood county, 39 per cent of Henry county and of Paulding county were so classed by the 1930 census. Corn predominates as a crop, occupying 32.2 per cent of the rotated area. Hay does not occupy as large a proportion of the area as in other sections, but this area is outstanding in the growing of alfalfa, 28 per cent of the hay acreage being in this legume, while in Lucas, Ottawa and Wood counties alfalfa made up one-half of the hay acreage in 1929. Oats predominate as a small grain, making up 23.4 per cent of the rotated area, an extent not reached in any other area. The area also includes most of the sugar beets raised in Ohio. With regard to livestock there is considerable diversity. Dairying ranks first as a source of farm income in Fulton county, beef cattle feeding is important in Wood, poultry provides much of the income of Henry county, while hogs are the leading source in Putnam county.

Area 2.

This area of level to gently rolling topography has about the same percentage of its rotated land in corn as Area 1. Roughly one-third of the rotated area is in intertilled crops, one-third in grass and one-third in small grains, with oats predominating. Thus there is more sod and less small grain than in Area 1. The area has more livestock than Area 1, particularly hogs and sheep. There are several centers of winter lamb feeding especially in the eastern part of the area. Hogs rank first and dairying second as sources of income in all counties except Union and Delaware, where the situation is reversed. Only about 8 per cent of the farm area is classed as cash grain farms by the census, except in Seneca county where one-sixth of the area is so classed.

Area 2a.

This area, largely Williams county, differs from the rest of northwestern Ohio, being more nearly like adjacent parts of Michigan and Indiana. The topography is more rolling, more of the farm land is in permanent pasture, and a smaller proportion of the rotated area is in corn. Because of the relatively smaller acreage of corn and larger acreage of hay, very little adjustment is necessary to bring about a balance with respect to the maintenance of soil productivity. As to livestock population per 100 acres in farms, the area is similar to Area 1, except for greater numbers of sheep. Most of the farms are classed as general farms by the census, while studies of the Department of Rural Economics show dairying the leading source of income, hogs second and poultry third.

Area 3.

The glacial limestone soils of this area are generally lighter in texture and of higher productivity than those of Area 2. The area is characterized by its large acreage of corn, its small acreage of hay, large amount of rotation pasture

and predominance of wheat as a small grain. In 1929 oats exceeded wheat in acreage in some parts of the area, particularly in Madison and Fayette counties, but in recent years the trend has been reversed. Tobacco of the Miami Valley cigar filler type is grown in the western part of the area where farms are small in size. In Madison, Fayette and Pickaway counties farms are large; here cattle feeding is common. The area is the leading section in Ohio in hog production, although dairying predominates in the urban centers in the Miami Valley.

Area 4.

The topography of the area varies from flat to steeply rolling. In general the soils are of low agricultural value and acid in reaction. The level areas have very poor drainage, those that are steep or rolling erode badly. In spite of the erosion problem, more than 40 per cent of the rotated area is in intertilled crops, including tobacco. Another characteristic of the area is the small acreage of small grains. Dairying is the important source of farm income within a 30-mile radius of Cincinnati; poultry farming is carried on extensively in Clermont county, while tobacco is the leading source of income in Brown and Adams.

Area 5.

This area differs from the one to the west in that it has more permanent pasture and more of its rotated area in hay. The soils are acid in reaction and generally less productive than those in Area 2. Wheat predominates as a small grain. Dairying is the leading source of farm income throughout the area and is especially important north and east of Columbus. Sheep are found in large numbers, especially in Knox, Morrow and Licking counties. General farming prevails in the northern part of the area.

Area 6.

This northeastern Ohio area is a narrow belt along Lake Erie, with a wide variety of soils ranging from heavy clays to fine sands. Production of fruit, nursery stock, and truck crops is important, the latter occupying a larger proportion of the rotated area than in other sections of the state. The average size of farm is only 59 acres, which is less than in any other area. Country estates are common. Only 57 per cent of the land of the area is in farms. Dairying is only of minor importance in much of the a rea; in Lake county, for instance, it ranked fourth as a source of income in 1930 and 1931.

Area 7.

This area of gently rolling to level topography has heavy soils that are very acid in reaction, and difficult to drain. Dairying is the leading source of income, with poultry ranking second. A rotation of corn, oats, wheat and two years of hay prevails.

Area 8.

The soils of the area are similar to those in Area 7. A decided difference exists in length of growing season, being shorter in Area 8. This in part accounts for a smaller percentage of the rotated area being in corn. Only about 42 per cent of the corn is harvested for grain, an equal amount is cut for silage, and the remainder harvested as fodder corn. Hay, largely timothy, makes up 48 per cent of the rotated area, a larger proportion than in any other area excepting Areas 13 and 14. Dairying is the leading livestock enterprise and the principal source of income. Wheat is not important, and the area does not produce enough corn or oats for the livestock that are kept. Practically no hogs are produced for sale.

Area 9.

This area of rolling topography includes considerable areas of soils especially adapted to the growing of wheat and potatoes. Except for larger acreages of these crops the type of farming carried on is similar in many respects to that in Area 7. Dairying is the leading source of income.

Area 10.

This is a narrow belt of rolling, well drained land in the central part of the state near the glacial boundary. The soils are acid and erosion is a problem. A larger portion of the rotated area was in wheat than in any other area in 1929. Oats are of minor importance. The area ranks high in numbers of sheep per 100 acres of farm land, due to large numbers in Knox and Licking counties. The area has a larger proportion of corn in the rotation than has Area 9 to which it is similar as to soils. The number of hogs per 100 acres in farms is larger than in any other part of eastern Ohio.

Area 11.

This is an area of rolling to hilly topography; erosion is a serious problem throughout the area, due to the continued farming of hills too steep for cultivation. Much of the pasture is of poor quality. This is a deficit area in the production of corn and oats. General farming prevails over most of the area.

Area 12.

This area contains the largest proportion of land of low productivity of any in the state. Much of the land is too steep for cultivated crops. A large part of the area is in woods. More of the non-productive and badly eroding lands should be taken out of farming and devoted to forestry. As to livestock, the area is least heavily stocked of any area in the state. Much of the agriculture is of a self-sufficing type; the agricultural income is low, there is much abandonment of land and increasing tax delinquency. This area, excluding the land in the Scioto Valley, is the most serious land-use problem of the state.

Area 13.

Because of the presence of limestone soils, excellent bluegrass pastures are found in this area, this being one of its distinguishing characteristics. Only about 30 per cent of the farm area is in crop land, and more than one-half in permanent pasture other than woods. Hay makes up nearly 56 per cent of the rotated area, a larger proportion than is found in any other area. Dairy cattle and sheep are the leading livestock enterprises.

Area 14.

This is another area of badly eroding soils of low productivity. Because of its rough topography much of the land is better adapted to forestry than to agriculture. Only 28 per cent of the land in farms is crop land. Thirty-five per cent of the rotated land is in intertilled crops. Within the area are some specialized centers, namely the Marietta truck crop section and the Rome Beauty apple producing sections of Lawrence and Gallia counties. There is a fair market for poultry products and fluid milk. Dairying ranks first as a source of income in Monroe county, poultry second. In Gallia and Meigs, poultry ranks first, dairying second.

Soil Characteristics of the Areas

A generalized soil map for the state was used as an aid in the determination of basic areas. Then from detailed and reconnaissance soil surveys, and from detailed data assembled in 1934 in the Soil Erosion Survey of Ohio. (Reconnaissance Soil Survey of the State of Ohio, Soil Conservation Service, U.S. Dept. of Agriculture) The extent of each major soil type or closely related types was determined for each of the 1337 townships in the state. From these data, assembled by areas, the portion of the area occupied by each soil type was calculated. Previously, all the principal soil types of the state had been ranked according to their productivity on a scale of "1" being the most productive soil and "10" the least productive. (See Special Circular No. 44 - "A Key to the Soils of Ohio" by Conrey and Paschall, Ohio Agricultural Experiment Station, 1934.)

By combining the percentages figures on the portion of each area occupied by a given soil type with the productivity ranking for that soil type, a weighted productivity ranking was obtained for each area. (Tables 2 and 3) The lower the figure for this ranking, the higher the native productivity of the composite soils of the area. The figures are to be regarded as rankings and not as exact linear relationships. They include all the soils of the area, and naturally selectivity of land in farms is higher in the areas of lower ranking.

Table 2 presents the portions of each area occupied by soils of various productivity rankings. This probably is as effective a picture as pages of descriptive text could give concerning the fundamental soil situations and problems of the areas.

In table 3, the areas are more fully characterized as to soils by showing the productivity rankings and extents of the most important soil types of the areas, the names of, extents of, the highest ranking, and lowest ranking soils.

Table 2.--Percentage of Each Area in Soils of the Various Productivity Rankings

Area	Productivity Ranking									Marsh and muck	Weighted productivity ranking for each area	Per cent each area is of total area of state
	1	2	3 & 3.5	4 & 4.5	5 & 5.5	6	7	8	9			
	%	%	%	%	%	%	%	%	%	%		%
1	42.1	7.6	28.4	2.2	7.9	3.7		7.8			2.7	10.3
2	26.2	5.7	.7	62.8		3.8				.7	3.1	12.5
2A	13.0	8.4		71.3		2.1					3.3	.9
3	14.5	11.4	57.9		15.0	.2				.7	2.9	16.2
4		5.4	5.8		51.9	19.5	17.0				5.3	5.7
5			8.0	71.9	18.6					1.1	4.3	3.8
6		12.7	7.6	17.4	7.2	26.8	17.5	9.3		1.1	5.1	2.2
7			8.1	21.8	38.2	.3	26.3	3.8		.7	5.3	5.0
8			5.2		12.8	1.7	64.9	14.2		.7	6.5	4.6
9			56.7	23.9	9.1	4.9	2.1		1.0	1.3	3.9	7.4
10		.8	41.9	29.0	20.0				7.5		4.4	2.2
11		2.6	.7	46.7	3.1	.1		.1	46.3		6.5	8.0
12		4.6	1.9	20.7	4.2	.7		.2	67.3		7.4	10.0
13		3.9	2.3	40.1	.1	33.1		6.2	13.9		5.5	5.3
14		5.5	2.5	9.6	.2	22.5		47.1	11.3	.7	6.7	5.9

Table 3.--Most Extensive, Highest and Lowest Ranking Soil Types of Each Area

Area	Weighted productivity ranking for the area	Most extensive soil types in the area			Highest ranking soils in the area			Lowest ranking soils in the area		
		Soil type	% of area	Productivity rank	Soil	% of area	Rank	Soil	% of area	Rank
1	2.7	Brookston clay & clay loam	40.0	1	Brookston	40.0	1	Plainfield	7.8	8
		Paulding clay	15.1	3	Toledo	9.7	1-2	Newton & Marsh land	3.7	6
		Toledo silty clay, silty clay loam, clay loam and loam	9.7	1-2						
		Wauseon fine sandy loam	8.5	3						
2	3.1	Miami silty clay loam & silt loam	62.8	4	Brookston	26.2	1	Crosby	3.8	6
		Brookston silty clay loam	26.2	1	Genesee	3.6	2			
2A	3.3	Miami silty clay loam & silt loam	71.3	4	Brookston	18.0	1	Crosby	2.1	6
		Brookston silty clay loam	18.0	1	Toledo	4.5	2			
3	2.9	Miami silt loam	34.1	3-4	Brookston	14.5	1	Fairmont	0.2	6
		Russell silt loam	18.5	3	Genesee	6.8	2	Finecastle	9.1	5
		Brookston silty clay loam	14.5	1	Fox	4.8	2	Crosby	5.9	5
		Finecastle silt loam	9.1	5						
4	5.3	Rossmoyne silt loam	26.5	5.5	Genesee	4.0	2	Clermont	17.0	7
		Cincinnati silt loam	20.3	5	Fox	1.4	2	Fairmont	19.5	6
		Fairmont silt loam	19.5	6						
		Clermont silt loam	17.0	7						
5	4.3	Cardington silt loam	45.7	4.5	Chagrin	4.1	3	Bennington	18.7	5
		Alexandria silt loam	20.4	4	Chenango	1.4	3	Cardington	45.7	4.5
		Bennington silt loam	18.7	5						
6	5.1	Canaoden silty clay loam	26.9	6	Lorain	10.8	2	Plainfield	9.3	8
		Mahoning silty clay loam	17.5	7	Toledo	1.9	2	Mahoning	17.5	7
		Painesville fine sandy loam	10.8	4	Chagrin	4.0	3			
		Lorain loam and silty clay	10.8	2						
7	5.3	Ellsworth silt loam & silty clay loam	31.3	5	Chagrin	4.1	3	Trumbull	3.7	8
		Mahoning silty clay loam	26.3	7	Wooster	4.0	3.5	Mahoning	26.3	7
		Rittman silt loam	19.8	4.5						

(table continued next page)

Table 3.--Most Extensive, Highest, and Lowest Ranking Soil Types of Each Area (Continued)

Area	Weighted productivity ranking for the area	Most extensive soil types in the area			Highest ranking soils in the area			Lowest ranking soils in the area		
		Soil type	% of area	Productivity rank	Soil	% of area	Rank	Soil	% of area	Rank
8	6.5	Mahoning silty clay loam	64.9	7	Chagrin	2.1	3	Trumbull	14.2	8
		Trumbull silty clay loam	14.2	8	Chenango	1.7	3	Mahoning	64.9	7
		Ellsworth silty clay loam	8.7	5	Wooster	1.4	3.5			
9	3.9	Wooster silt loam	51.5	3.5	Chagrin	2.9	3	Muskingum (steep)	1.0	9
		Canfield silt loam	16.5	4	Chenango	2.6	3	Trumbull silt loam	2.1	7
		Volusia silt loam	9.0	5	Wooster	51.5	3.5	Mahoning silt loam	2.5	6
10	4.4	Wooster silt loam	29.5	3.5	Huntington	0.9	2	Muskingum - steep	7.6	9
		Hanover silt loam	20.0	5	Chenango	7.8	3	Hanover	20.0	5
		Cardington silt loam	13.7	4.5	Chagrin	4.8	3	Muskingum	4.9	4.5
		Chenango silt loam	7.8	3						
11	6.5	Muskingum silt loam-steep phase	46.4	9	Huntington	2.6	2	Muskingum - steep	46.4	9
		Muskingum silt loam	36.1	4.5	Wheeling	2.1	3	Meigs - steep	.1	8
		Pope silt loam	8.2	4.0	Wooster	0.6	3.5	Meigs silty clay loam	.1	6
					Pope	6.2	4			
12	7.4	Muskingum silt loam-steep phase	67.3	9	Genesee	2.2	2	Muskingum-steep	67.3	9
		Muskingum silt loam	12.0	4.5	Fox	1.4	2	Meigs	.2	8
		Pope silt loam	6.6	4	Huntington	1.0	2			
		Monongahela silt loam	4.2	5						
13	5.5	Westmoreland silty clay loam-steep phase	29.6	6	Huntington	3.9	2	Muskingum - steep	14.0	9
		Westmoreland silty clay loam	27.9	4	Chenango	1.7	3	Meigs - steep	6.2	8
		Muskingum silt loam-steep phase	14.0	9	Wheeling	.7	3			
		Muskingum silt loam	11.6	4.5						
14	6.7	Meigs silty clay loam-steep phase	45.5	8	Huntington	5.6	2	Muskingum - steep	11.4	9
		Meigs silty clay loam	22.6	6	Wheeling	2.6	3	Meigs - steep	45.5	8
		Muskingum silt loam-steep phase	11.4	9						
		Muskingum silt loam	7.1	4.5						

Productivity of Ohio Soils on the Decline

One often hears naive expressions about how the adoption of scientific practices have increased crop yields. While for many individual farms crop yields have been turned upward, no such pronounced tendency can be shown for the farms of Ohio as a whole. An examination of average annual yields by decades is pertinent.

Table 4.--Crop Yields in Ohio - Average

	Corn bus.	Oats bus.	Wheat bus.	Hay tons
60 years ago, 1870-79	36.9	27.7	13.3	1.03
40 years ago, 1890-99	34.3	29.1	14.6	1.07
20 years ago, 1910-19	37.0	36.4	17.5	1.10
10 years ago, 1920-29	37.2	35.1	16.5	1.15
For comparison, the 29-year average yield on the 45-acre variety test field at Wooster (annual cash outlay for lime and fertilizer, $3.50).	73.6	62.0	34.6	3.00

The corn yields are little different from those of 60 years ago; the yield of oats increased for a time primarily as a result of the draining of large areas of northwestern Ohio, well adapted climatically to oats production. Wheat yields advanced when the use of fertilizer became rather common on this crop, but receded with lower prices.

During the past 60 years yields might have been expected to increase notably with the adoption of various improved practices; drainage, irrigation, rotations, liming, wider use of legumes, green manures, use of fertilizer in the soil, improved and more timely tillage practices; conservation of manure, improved varieties of crops, better seed, insect and disease control programs, etc. It appears, however, that these practices, in so far as actually adopted, have merely balanced the downward trend in the average ability of the soil of Ohio to produce. On the side of destruction have been such factors as:

1. Removal of plant nutrients, far more than returned.
2. Erosion losses.
3. Decreasing organic matter content of the soils.
4. Increasing acidity of the soils.
5. Increasing menace of weeds, insects, and diseases.

That the decline in productive ability of the average Ohio soil is not inevitable is demonstrated forcibly by the yields on the 45-acre variety tract at Wooster (Table 4). Here, an intelligent (not always the most advanced) and relatively low cost system of soil and crop management results in yields averaging twice those obtained on the average farm in Ohio. At the start of this system, the soil on this tract was no better than the average Ohio soil.

Apparently, then, the productive ability of Ohio soils has been on the downgrade, and threatens to reach the point where improved practices, as previously applied on the average, may no longer stay the decline in average yields. Basically, adjustment programs must approach the problem of soil conservation. The high proportion of grain crops on rotated farm areas has been a basic factor in reducing the native productive abilities of Ohio soils.

Crop Adjustments Designed for Maintenance of Soil Productivity

Would it be possible to alter the cropping systems in such a way as to check the downward decline in productive ability? Recent studies of the 40-year-old fertility plots at Wooster and shorter experiments on other experiment farms of the state have demonstrated a close relationship between organic matter content, within a soil type, and ability to produce crops. From these studies and those at Wooster and Zanesville on losses by erosion, standards for estimating the effects of cropping systems on soil conservation were developed and used as a basis for the crop adjustment studies (table 5).

Table 5.--Standards for Estimating Effects of Cropping Systems on Soil Conservation

	Annual change in soil productivity	
	Non-livestock farms	Livestock farms*
	Per cent	Per cent
Corn	-2.0	-1.8
Potatoes, tobacco, sugar beets	-2.0	-2.0
Oats, wheat, barley, rye, buckwheat	-1.0	- .8
Soybeans - Hay	-1.0	- .5
Seed - straw and leaves left on field	-0.5	0.0
Timothy and other grass sods	0.0	+.3
Red and alsike clovers	+2.0	+2.5
Alfalfa (1 year)	+2.5	+3.0
Alfalfa (2 years or more)	+3.0 (total)	+4.0(total)
Sweet clover (green manure)	+2.5	+2.5
Rotation pasture	According to type of sod	

Light colored, non-eroding soils - add 20 per cent on positive side.
Eroding soils - No. 2 Erosion - 30 to 50 per cent greater deduction
No. 3 " - 50 to 75 " " " "
No. 4 " - 75 to 100 " " " "

* In the case of livestock farms, 60 per cent of the value of the manure was estimated to be returned to the soil.

If soil conservation is to be effected, the losses in productivity resulting from production of the grain crops must be counterbalanced by forage crops. The longer lived the forage and the higher the proportion of perennial legumes in it, the greater will be the positive or corrective effect on productivity. (In this discussion "productivity" is not quite synonymous with "fertility." A crop of alfalfa may remove large quantities of phosphorus and potash from the soil, and yet the alfalfa may leave the soil with a greater ability to produce corn than it had before.)

In applying these standards to the 1929 distribution of crops on the rotated portion of each area, certain difficult problems were encountered. In the first place, one must realize that averages and average trends are being discussed and used, not figures that would apply to the exceptional farm - be it markedly above or below the average. In areas where the farmers tend to conserve and distribute manure more effectively and/or where above the average amounts of feed are purchased per 100 acres in farms, the standards for deductions were modified for corn from -1.8 to -1.7 or -1.6.

Additional deductions made on account of erosion were:

Area 4 - 40 per cent of the crop reductions for 2/3 of the area.
Area 9 - 40 per cent of the crop reductions for 2/3 of the area.
Area 10 - 50 per cent of the crop reductions for 3/4 of the area.
Area 11 - 80 per cent of the crop reductions for 3/4 of the area.
Area 12 - 70 per cent of the crop reductions for 1/2 of the area.
Area 13 - 60 per cent of the crop reductions for all of the area.
Area 14 - 100 per cent of the crop reductions for 4/7 of the area.

From table 5 it is obvious that the degree of balance in terms of soil conservation, depends largely upon extent and type of biennial and perennial forage crop. For each area, a weighted productivity factor was determined for the hay and rotation pasture portion of the cropping system. There were difficulties in arriving at this factor, for the census reports "Timothy" and "Timothy Mixed" as one item. From meager data and informed estimators, figures for these two items were assigned for each area. Allowances were also made for the use of sweet clover, rye, etc. as green manure crops.

Examination of 1929 Crop Distribution

The 1929 distribution of rotated crops in each area was analyzed by applying these productivity factors (table 6). At once it is noted that areas 2a and 8 were only slightly out of adjustment as of 1929, and that areas 6, 7 and 13 were sufficiently near balance that minor adjustments or improvements in the 1929 usages would effect a balance. The other areas, however, were rather seriously out of balance - Areas 1, 2, and 3 because of excess corn and grain acreages, and the remaining Areas (4, 5, 9, 10, 11, 12, and 14) because of the marked needs for lime to improve the forage crops, and the serious problem of erosion, as well as excess acres in grain crops. It is probable that the seriousness of the erosion factor was minimized rather than exaggerated in applying the productivity factors.

Making the Crop Adjustments

Soil productivity is reduced more rapidly by corn than any of the major farm crops; corn is also a high income crop. In the concentrated corn areas of western Ohio, the attempt was made to reduce the corn acreage by eliminating the area devoted to corn 2 or more years in succession. Actually the reductions suggested do not quite do this. (Tables 7 and 8.)

The suggested reductions in wheat and rye would be more severe than indicated because the wheat acreage in 1929 was abnormally low (table 7). On the other hand the oats reductions appear to be very high, but actually the oats acreage is trending downward in Ohio, so that the actual adjustments from existing acreages (in 1934 and 1935) are slight. The soybean acreage increases look large due to a small base in 1929. By 1935 an increase of more than 40 per cent has been made over 1929, and new commercial outlets and wider experience with soybeans suggest further considerable increases.

The percentage of the rotated area in hay and rotation pasture was increased by the amount deducted from the crops on the negative side of the soil conservation ledger.

Table 6.--Weighted Positive and Negative Productivity Factors Before and After Suggested Shifts in Use of Rotated Area as of 1929

Area	As used in 1929			Possible under suggested usage			Other major difficulties in adjustment for soil conservation
	Negative -	Positive +	Out of balance by	Negative -	Positive +	Variation from balance	
1	.99	.66	-.33	.89	.83	-.01	
2	.85	.50	-.35	.76	.75	-.01	
2a	.76	.68	-.08	.72	.76	+.04	
3	.95	.61	-.34	.83	.83	-	
4	1.09	.49	-.60	.96	.69	-.27	Erosion + lime needs
5	.79	.44	-.35	.69	.61	-.08	Slight erosion + lime needs
6	.84	.60	-.24	.78	.73	-	
7	.74	.54	-.19	.67	.63	+.01	
8	.60	.52	-.08	.60	.63	+.03	
9	.94	.54	-.40	.86	.60	-.17	Erosion + lime needs
10	1.04	.52	-.52	.89	.70	-.19	Erosion + lime needs
11	1.04	.63	-.41	.93	.79	-.14	Erosion + lime needs
12	1.26	.50	-.76	1.07	.72	-.39	Erosion + lime needs + concentrated corn on bottom lands
13	.88	.71	-.17	.85	.87	+.02	Erosion
14	1.10	.52	-.58	.97	.72	-.25	Erosion + lime needs

Table 7.--Comparative Crop Acreages for 1929, 1934, and as Suggested

Totals for State of Ohio

	Actual acreages		Suggested acreages			Percentage changes					
						From 1929			From 1934		
	1929	1934	(A) With rotated area as in 1929	(B) with adjusted rotated area, but same farm area as 1929*	(C) With adjustments in both rotated and farm areas*	A	B	C	A	B	C
Corn	3,473,143	2,947,000	2,953,267	2,897,956	2,842,402	- 15.0	- 16.6	- 18.2	+0.9	- 1.0	- 2.9
Oats	1,612,758	1,209,000	1,246,074	1,230,947	1,208,814	- 22.7	- 23.7	- 25.0	+3.1	+ 1.8	0.0
Wheat	1,563,740	1,737,000	1,541,014	1,513,927	1,484,666	- 1.5	- 3.2	- 5.1	- 11.3	- 12.8	- 14.5
Soybeans	86,642	112,000	247,635	241,800	236,270	+185.8	+179.1	+172.7	+121.1	+115.9	+111.0
Hay	2,625,351	2,629,000	2,967,728	2,904,577	2,788,080	+ 13.0	+ 10.6	+ 6.2	+12.9	+10.5	+ 6.1
Rotation pasture	1,196,894		1,568,487	1,540,314	1,519,904	+31.0	+ 28.7	+27.0			
Hay and rotation pasture	3,822,243		4,536,215	4,444,891	4,307,984	+18.7	+16.3	+12.7			

* (B) In several areas it was recommended that the rotated farm acreage be reduced below that of 1929 by shifting a part of the crop land to permanent pasture.

(C) In several areas of southeastern Ohio large areas of land of low agricultural value should be retired from farms and devoted to forestry. This column shows the combined effect of recommended changes in cropping systems, the shift of some crop land to permanent pasture, and the retirement of about 1,450,000 acres from farms.

Table 8.--Per cent of 1929 Rotated Area in Indicated Crops and Possible Changes in Yields

A = 1929 C = Change and per cent change from 1929 E = Possible per cent change in yield 1946-1947*
B = Suggested D = Possible per cent change in yields 1936-1937*

Area		Corn	Potatoes, tobacco, sugar beets, veg. crops	Wheat and rye	Oats and barley	Soybeans	Hay and rotation pasture	Productivity ranking of soils (N)
1	A	32.2	2.4	12.7	25.4	.45	24.5	2.7
	B	28.0	3.5	12.7	19.8	1.5	32.2	
	C	4.2 -13.0%	1.1 +45.8%	-- --	5.6 -22.0%	1.05 +233.0%	7.7 +31.4%	
	D	3	-	0	5	-	5	
	E	9	10	7	10	10	10	
2	A	32.3	1.0	12.9	18.8	1.1	32.4	
	B	27.5	1.5	12.9	13.8	2.5	40.3	
	C	4.8 -14.9%	.5 +50.0%	-- --	5.0 -26.6%	1.4 +127.2%	7.9 +24.4%	3.1
	D	3	-	0	5	-	5	
	E	12	10	7	10	10	15	
2a	A	24.8	.8	13.8	21.0	.2	36.5	
	B	24.0	1.0	13.5	19.0	1.0	38.4	
	C	.8 -3.2%	.2 +25.0%	.3 -2.1%	2.0 -9.5%	.8 +400.0%	2.1 +5.7%	3.3
	D	2	-	-	5	-	-	
	E	7	10	5	10	10	10	
3	A	37.0	2.3	17.1	12.3	.5	30.2	
	B	30.0	2.5	18.1	9.0	3.0	36.8	
	C	7.0 -18.9%	.2 +8.7%	1.0 +5.8%	3.3 -26.8%	2.5 +500.0%	6.6 +21.9%	2.9
	D	4	-	-	5	-	5	
	E	12	10	5	12	10	15	
4	A	36.4	4.8	10.7	4.4	2.3	41.9	
	B	29.0	5.0	10.0	3.0	5.0	47.5	
	C	7.4 -20.3%	.2 +4.1%	.7 -6.5%	1.4 -31.8%	2.7 +117.4%	5.6 +13.3%	5.3
	D	3	-	2	8	-	3	
	E	8	10	10	10	10	5	

* These yield changes are to be expected only if the crop distribution is changed as suggested and prospective accompanying changes in selectivity, soil and crop improvement and management occur.

(N) Rankings are on the basis of "1" being the highest productivity, and "10" the lowest.

Table 8.--Per cent of 1929 Rotated Area in Indicated Crops and Possible Changes in Yields (Continued)

A - Before
B - After C - Change

Area		Corn	Potatoes, tobacco, sugar beets, veg. crops	Wheat and rye	Oats and barley	Soybeans	Hay and pasture rotation	Productivity ranking of soils
5	A	30.4	1.2	15.3	13.0	1.3	37.7	
	B	25.4	1.5	14.0	11.0	2.5	44.5	
	C	5.0 -16.4%	+.3 +25.0%	1.3 -8.5%	2.0 -15.4%	1.2 +92.3%	6.8 +18.0%	4.3
	D	3	-	2	5	-	5	
	E	12	10	10	10	10	10	
6	A	20.9	10.6	17.2	16.4	.3	32.5	
	B	19.5	11.0	16.0	13.0	1.0	37.4	
	C	1.4 -6.7%	+.4 +3.8%	1.2 -7.0%	3.4 -20.7%	.7 +223%	4.9 +15.1%	5.1
	D	2	-	2	5	-	5	
	E	9	10	10	10	10	10	
7	A	22.7	3.4	17.5	16.6	.3	37.9	
	B	21.4	4.0	16.0	14.0	1.0	42.0	
	C	1.3 -5.7%	.6 +17.6%	1.5 -8.6%	2.6 -15.7%	.7 +233%	4.1 +10.8%	5.5
	D	2	-	2	5	-	3	
	E	12	10	10	10	10	10	
8	A	19.9	3.2	6.1	18.1	.5	48.2	
	B	19.5	3.5	6.0	17.0	1.0	49.4	
	C	.4 -2.0%	.3 +9.4%	.1 -1.6%	1.1 -6.0%	.5 +100%	1.2 +2.5%	6.5
	D	-	-	-	2	-	2	
	E	9	10	5	5	10	5	
9	A	22.0	3.6	21.1	16.4	.2	36.3	
	B	20.0	4.0	19.0	13.0	1.0	41.6	
	C	2.0 -9.1%	.4 +11.1%	2.1 -9.9%	3.4 -20.7%	.8 +400%	5.3 +14.6%	3.9
	D	2	-	2	4	-	3	
	E	7	10	8	8	10	10	

Table 8.--Per Cent of 1929 Rotated Area in Indicated Crops and Possible Changes in Yields (continued)

A - Before
B - After C - Change

Area		Corn	Potatoes, tobacco sugar beets, veg. crops	Wheat and rye	Oats and barley	Soybeans	Hay and rotation pasture	Productivity ranking of soils
10	A	29.7	.9	22.0	4.6	.3	41.0	
	B	25.0	1.0	19.0	4.0	1.5	48.2	
	C	4.7 -15.8%	.1 +11.1%	3.0 -13.6%	.6 -13.0%	1.2 + 400%	7.2 +17.6%	4.4
	D	2	-	2	4	-	3	
	E	7	10	8	8	10	8	
11	A	21.9	1.3	16.1	12.0	.4	49.3	
	B	20.0	1.5	15.0	10.0	1.0	53.5	
	C	1.9 -8.7%	.2 +15.3%	1.1 -6.8%	2.0 -16.7%	.6 + 150%	4.2 +8.5%	6.5
	D	2	-	-	4	-	3	
	E	6	10	5	6	10	8	
12	A	38.8	3.1	11.6	6.0	1.4	37.6	
	B	31.0	3.5	11.0	5.0	2.0	46.2	
	C	7.8 -20.3%	.4 +12.9%	.6 -5.1%	1.0 -16.6%	.6 +42.8%	8.6 +22.8%	7.4
	D	4	-	-	4	-	5	
	E	9	10	5	6	10	10	
13	A	22.8	2.0	6.7	10.8	.7	57.7	
	B	22.0	2.0	8.0	9.0	1.0	58.7	
	C	.8 -3.5%	- -	1.3 +19.4%	1.8 -16.6%	.3 +42.8%	1.0 +1.7%	5.5
	D	0	-	-2	5	-	5	
	E	9	10	5	8	10	15	
14	A	30.0	4.8	8.1	6.8	2.7	49.5	
	B	27.0	5.0	7.0	5.0	4.0	53.9	
	C	3.0 -10.0%	.2 +4.2%	1.1 -13.6%	1.8 -26.5%	1.3 +48.1%	4.4 +8.9%	6.7
	D	2	-	3	-	-	3	
	E	6	10	8	5	10	8	

Crop Adjustments Alone Will not Effect Conservation

It is evident that any reasonable shift in the use of the rotated areas as of 1929 will not alone bring about soil conservation. In calculating the productivity factors after adjustments of crops, the weighted positive factor for the hay and rotation pasture area was raised by .1, .2, or .3 in each area, partly because there has been an improvement in type and extent of forage since 1929, partly because such changes will be encouraged by reduction of the acres in grain, and partly because use of lime must be on the upgrade to obtain satisfactory forage cover.

Areas 4 to 14 inclusive all require large quantities of lime. The lime needs of Areas 1, 2, 2a, and 3 are rapidly becoming more acute, though the naturally high lime soils of this area have never been utilized as fully as they could be in growing higher types of legumes.

Erosion control programs, entailing field rearrangement, contour farming, contour furrowing, field stripping, and buffer strips, reforestation, judicious threshing, and improvement of the forage cover in meadows and pastures, will be required to bring Areas 4, 9, 10, 11, 12, 13 and 14 into balance for soil conservation.

It is interesting to note that the farm and crop distribution suggestions for Area 11 are essentially in agreement with the planning program of the Salt Creek Erosion Control Project which is partly in this area.

Prospective Crop Yield Changes

If the suggested changes in crop distribution were made, and if the areas suggested are retired from farm land and from rotated land in farms and if the calculated changes were to occur in types and extent of forage crops, and if these changes are accompanied by certain logical and anticipated changes in soil and crop management, then the yield per acre changes suggested in table 8 might reasonably be expected for 1936-1937 (D in the Table) and for 1946-1947 (E in the table).

For instance in the case of corn, factors that would affect the yields under such conditions might be:

(a) Retirement from production of some low producing areas.

(b) Greater selectivity of the land put to corn.

(c) The positive effect of high type legume sods on increasing yields of succeeding crops. (Abundant experimental and experience data demonstrate considerable increases.)

(d) Less corn acreage usually results in more thorough and timely soil preparation and cultivation.

(e) Row fertilization of corn alone, if generally applied under such circumstances, would nearly accomplish the increases.

By 1941 the entire corn acreage of Ohio could be planted to superior hybrids having yielding abilities of 10 to 20 per cent above existing corns. This will probably have a more certain effect on yield than many of the factors just enumerated and should, in a 10-year period, result in an additional 6 to 12 per cent increase in average yields. This increase has not been included in the figures in Table 8.

The Danger in Averages

(a) From Standpoint of Soil Conservation of an Area as a Whole.

In these studies, averages must be used as a means of expression. In adjusting these areas by crop changes, use of lime, improved management, and erosion control measures, the use of averages may lead to a false hope. To say that these changes would bring any area into balance is assuming that these practices will obtain to a given point on every farm in the area. In other words, all farms below the average in adoption of these changes and practices will be on the down-grade as far as soil productivity and conservation are concerned. The number of and the degree of departure from a soil conservation basis on these farms will determine the trend in the loss of native productive values for the area as a whole.

(b) From the Standpoint of the Individual Farmer.

There should be no assumption that every farmer in an area would be expected to approach the suggested percentages on crop distribution for his area. (Table 8) For instance in Area 3, the averages suggested are:

Corn 30.0% of the rotated area
Wheat (and rye) 18.1% of the rotated area
Oats (and barley) 9.0% of the rotated area
Hay and rotation pasture 36.8% of the rotated area

If an individual farm on a typical soil type of this area satisfied the following conditions:

1. All forage (hay, rotation pasture, and green manure) in the rotated area regularly and consistently, clover, alfalfa, and/or sweet clover; (this implies the use of lime as needed for these crops);

2. The crops (except wheat grain) fed on the farm, the value of the manure conserved and applied over the entire rotated area;

3. The legume seedings fertilized with superphosphate or 0-14-6 either when seeded in small grain or without a companion crop;

4. The wheat crop fertilized with superphosphate or 0-14-6;

5. The corn crop fertilized in the row or hill;

6. Erosion control methods where needed;

then with 1/3 of the rotated area regularly and consistently in the indicated types of legumes it would be possible to have a balance in soil conservation and yet have 35 to 40 per cent of the rotated area in corn and 25 to 20 per cent of the rotated area left for the small grains.

However, a farm operated under an inferior cropping and management system should have the acreages of the productivity-reducing grain crops markedly lower than the suggested averages for the area. For instance, again in area 3 suppose the farm operations are characterized by:

1. Poor, uncertain meadows and rotation pasture, mostly grass - clover crops irregular and only occasionally up to the average;

2. No lime applications;

3. Most of the crops sold - only a few head of livestock kept - manure mostly left in the barnyard;

4. Fertilizer used only occasionally on wheat - seldom or not at all for corn; then as little as 20 per cent of the rotated area in corn and 20 per cent in small grains would result in a considerable reduction in the productivity of the soil.

It is evident that the individual farm adjustments as to conservation of the soil should be made according to the past and present soil- crop- and livestock-management practices.

Change in Type and Extent of Forage

Previously it has been mentioned that changes in quality as well as extent of forage are necessary in order to bring about a soil conservation balance. In Area 3, for instance, the weighted productivity factor for the hay and rotation area of 1929 was determined as 1.8 on the basis of the hay distribution of 1929.

In figuring the adjusted acreages a productivity factor of 2.1 was used. Hence, to attain balance, more red clover, alfalfa and sweet clover will have to be used, possibly somewhat as suggested below.

Type of hay	1929	Proportions needed to adjust
Timothy	21.3	18
Mixed	40.0	22
Clover	22.3	20
Alfalfa and sweet clover .	11.9	35
Soybean	3.1	4

Some of this change would be accomplished if sweet clover were more regularly and widely grown on the small grain land to be plowed for corn.

Much of this change can be made in this area (3) without extensive costs for lime, in fact, far more of this area will produce alfalfa and sweet clover than is now being so cropped. The mistaken idea that alfalfa is not a rotation crop has retarded its wider use in this area.

In eastern Ohio, the changes in forage would need to be less in quantity, but probably more striking in quality. For instance, in Area 9 an increase in the clover and alfalfa hay acreage from 15.3 per cent of the hay area to 25 or 30 per cent of the hay area would be required to raise the soil conservation and productivity faster from 1.2 in 1929 to 1.5. This change is essentially a matter of lime applications.

Greater Lime Use Fundamental to Improvement in Use of Land in Ohio

The necessity for increasing the proportion of alfalfa and clover in the forage of the state as a means of combating soil deterioration has been stressed. That such an increase is vitally dependent upon an increased use of lime cannot be overemphasized. Excepting the dark colored limestone soils of Western Ohio, few unlimed

soils of the state will now grow alfalfa. More than half of the state is too acid to grow satisfactory clover. Moreover, the soils of the state are becoming increasingly acid since the amounts of lime used (the peak tonnage was 233,000 tons in 1929) are estimated to be only one-fourth that needed to maintain the soils at their present reaction status. It is estimated that to put the cropped land of Ohio in condition to grow alfalfa within a 25-year period and at the same time compensate for annual losses of lime through crops and drainage would require the yearly application of around 2,000,000 tons of limestone. Such an increase in lime use is highly improbable.

The immediate shifts in crop acreages and estimates of yield changes suggested in this report do not imply any increase above the 1929 level of lime usage. The possible situation suggested for 1946-1947 does involve an increase in the alfalfa acreage of about 50 per cent above that of 1934 and a considerable increase in the proportion of clover on the remaining hay acreage. For these changes to be effected it is estimated that the annual amounts of lime applied to the soils of the state will have to be increased from the 1929 level of 233,000 tons annually to at least 500,000 tons.

Few realize what changes the use of lime and the accompanying changes of meadows from timothy to clover or alfalfa may bring about on the non-limestone soils that have dropped to below average productivity.

On Canfield silt loam at Wooster in Area 9, an expenditure for limestone of $5.13 per rotation has raised the soil reaction from pH of 5.0 to pH of 6.8, and made it possible to substitute alfalfa for timothy in a three-year rotation of corn, small grain, meadow. As a result of the use of lime and the shift to alfalfa, the total value of the crops per rotation has been raised from $34.97 to $86.46 - or a net gain of $46.36 in crop values for an average expenditure of $5.13 for limestone per rotation. (Table 54, Special Circular 46 - 1935, Ohio Agricultural Experiment Station. Compare also Table 70 for other data on the cost of failure to use lime). In such areas the question becomes with lime, "Can one afford NOT to use it?"

Adjustment of Crop Acreage

The rotated acreage or the sum of rotation pasture and harvested crops (less orchards and small fruits) was reduced from the 1929 base in Areas 3, 4, 5, 11, 12 and 14 by shifting some land from crops to permanent pasture. Taking the recommended rotated acreage of these six areas and the 1929 rotated acreage of the remaining areas as a base, and applying the recommended percentage figures as given in line B, Table 8, the recommended acreage of each crop was calculated. Production of each crop, on the basis of expected yields resulting from the recommended changes, was computed for two periods, 1936-1937 and 1946-1947. Adjusted acreages were computed on two bases for each area; first, with no land retired from the land now in farms, second, with a recommended area retired from land now in farms. In the large sheets entitled "Summary of Proposed Changes" the data given are only for the first basis.

Thus the calculations show only the effects of changes in cropping systems and not the combined result of the recommendations and the retirement of land from farms.

It should be noted that the wheat acreage recommended for the state is less than that grown in 1935. If it seems desirable to grow more wheat it may replace more of the oat acreage and thus continue the trend which has existed since 1928.

Adjustment of Livestock Numbers

It was assumed that adjustments in crop acreages would lead to adjustments both in livestock numbers and in feeding practices. In calculating the results of the foregoing changes in the cropping system upon the livestock industry, the following assumptions were made:

(1) Hogs

It was assumed that the total amount of corn fed to hogs would be decreased in the same proportion as the decrease in corn production. One-half of this loss of hog production through the decrease in the amount of corn would be made up by more extensive use of legume pasture. In other words if there was a reduction of 20 per cent in corn production, this would result in a 10 per cent reduction in the number of hogs sold.

(2) Dairy Cattle.

It was recommended that the number of dairy cattle be increased 8 per cent from the January 1, 1930 figure. This is a slight decrease from those on hand at the beginning of 1935. The amount of corn fed per cow and per head of other dairy cattle would be decreased by the same per cent as the decrease in corn production in the area. This decrease in corn fed would be made up by the use of more and better quality of hay and pasture. This is a trend which is now under way in the state. It was estimated that by 1946 the production per dairy cow would increase by 5 per cent as a result of better quality hay.

(3) Poultry.

It was assumed that the number raised, feeding practices, and egg production would remain the same as in the base period.

(4) Horses.

It was assumed that the number of farm horses would remain the same as in 1929, and that the amount of corn fed to horses would be decreased by 10 per cent, the decrease in corn fed to be made by the use of more and better quality of hay.

(5) Sheep.

Since hay and pasture make up a large part of the feed for sheep, they were increased in number in proportion to the increased production of pasture in each area. It was assumed that the total amount of corn fed to the larger number of sheep would remain the same as in the base period, the hay consumption per sheep being increased to make up for the loss in corn.

In calculating the increased hay and pasture production in a given area, rotation pasture was given the same yield per acre as hay, while permanent pastures were appraised as a rule at from one-half to one-fourth the carrying capacity of an acre of hay.

(6) Beef Cattle.

It was assumed that, in areas where feeder cattle are now purchased, more young stuff would be raised to the extent of decreasing the purchase of feeder

cattle by 50 per cent in the first period and by 60 per cent in 1946. The gross sales of beef cattle in terms of pounds would remain the same as in the base period. It was assumed that there would be less corn fed to fattening cattle, to be made up by more and better hay and pasture. The total number of bushels of corn fed to all beef cattle, however, would remain practically the same, due to a necessary increase in the number of beef cows, bulls and young stock.

In areas where few or no feeder cattle are now purchased it was assumed that the net gain in beef cattle production would be in proportion to the increase in hay and pasture.

Computing Income

The deductions made from gross crop production to provide for livestock feed were based upon data obtained from cost accounts collected by the Department of Rural Economics. The surplus amounts of the different crops available for sale were checked with the "percentage shipped out of county where grown" as estimated by the Bureau of Agricultural Economics, and with previous studies made by the Experiment Station on the income of Ohio agriculture. Only the major sources of income from sales are included in the income estimates in the current study. These commodities are listed in table 9.

Two series of prices were used in the income calculations: Series A, based on a national production equal to that of 1928-1932 and estimated 1936-1940 demand, and Series B, based on moderate adjustments in production from the 1928-1932 level. These price series, prepared by the United States Department of Agriculture for the nation as a whole, were adjusted so as to be in line with Ohio farm prices and further to reflect the variations in price within the 15 Ohio areas.

Table 9.--Prices Used in Computing Income

Price Series A

Area	Corn	Wheat	Oats	Hay	Hogs	Beef	Veal	Milk	B.F.	Sheep	Lambs	Wool	Chick-ens	Eggs
	Per bu.	Per bu.	Per bu.	Per ton	Per cwt.	Per cwt.	Per cwt.	Per cwt.	Per lb.	Per cwt.	Per cwt.	Per lb.	Per lb.	Per doz.
1	.48	.57	.28	8.71	6.32	6.21	8.76	1.56	.25	3.84	7.85	.25	.14	.19
2	.49	.57	.28	9.19	6.32	6.30	8.51	1.62	.24	3.81	7.78	.26	.13	.19
2a	.47	.57	.28	8.51	6.31	6.22	8.76	1.52	.25	3.90	7.78	.24	.14	.18
3	.49	.57	.30	9.85	6.40	6.36	8.26	1.70	.24	3.71	7.74	.26	.14	.20
4	.52	.57	.34	11.22	6.39	6.05	8.26	1.79	.24	3.50	7.70	.25	.14	.21
5	.51	.57	.30	8.97	6.38	6.19	8.26	1.76	.24	3.92	7.87	.26	.13	.20
6	.53	.57	.32	10.70	6.40	6.02	8.59	1.82	.26	3.98	8.19	.25	.15	.20
7	.53	.57	.32	10.32	6.40	6.00	8.59	1.83	.26	4.02	8.19	.25	.15	.20
8	.54	.57	.35	11.96	6.43	5.87	8.67	1.92	.27	4.33	8.25	.25	.16	.21
9	.54	.57	.34	11.47	6.39	5.92	8.67	1.87	.26	4.20	8.15	.26	.15	.21
10	.52	.57	.32	8.95	6.33	6.11	8.09	1.77	.24	4.11	7.58	.27	.13	.20
11	.56	.57	.35	10.61	6.31	5.92	8.09	1.75	.25	4.15	7.56	.29	.14	.20
12	.56	.58	.37	10.17	6.25	5.67	7.92	1.83	.24	4.02	7.31	.26	.13	.20
13	.60	.58	.39	10.37	6.15	5.79	8.01	1.75	.25	4.27	7.08	.29	.14	.20
14	.59	.59	.39	10.12	6.16	5.64	7.67	1.81	.25	4.19	7.06	.27	.13	.20

Table 9.--Prices Used in Computing Income (Continued)

Price Series B

Area	Corn	Wheat	Oats	Hay	Hogs	Beef	Veal	Milk	B.F.	Sheep	Lambs	Wool	Chickens	Eggs
	Per bu.	Per bu.	Per bu.	Per ton	Per cwt.	Per cwt.	Per cwt.	Per cwt.	Per lb.	Per cwt.	Per cwt.	Per lb.	Per lb.	Per doz.
1	.60	.74	.35	8.71	8.53	7.05	9.96	1.74	.27	3.97	8.12	.25	.14	.19
2	.61	.74	.35	9.19	8.52	7.16	9.68	1.80	.27	3.95	8.05	.26	.13	.19
2a	.59	.74	.35	8.51	8.51	7.07	9.96	1.69	.27	4.03	8.05	.24	.14	.18
3	.62	.74	.38	9.85	8.61	7.20	9.40	1.89	.27	3.88	8.00	.26	.14	.20
4	.65	.75	.42	11.22	8.61	6.87	9.40	1.98	.27	3.62	7.97	.25	.14	.21
5	.63	.74	.37	8.97	8.61	7.03	9.40	1.96	.27	4.06	8.14	.26	.13	.20
6	.65	.75	.39	10.70	8.62	6.84	9.77	2.03	.28	4.12	8.46	.25	.15	.20
7	.66	.74	.40	10.82	8.62	6.83	9.77	2.04	.28	4.16	8.47	.25	.15	.20
8	.67	.74	.43	11.96	8.66	6.68	9.87	2.14	.29	4.48	8.54	.25	.16	.21
9	.67	.74	.42	11.47	8.63	6.73	9.87	2.08	.29	4.35	8.44	.26	.15	.21
10	.66	.74	.40	8.95	8.54	6.94	9.21	1.97	.27	4.26	7.85	.27	.13	.20
11	.70	.74	.44	10.69	8.47	6.73	9.21	1.95	.28	4.30	7.83	.29	.14	.20
12	.70	.75	.46	10.17	8.43	6.39	9.02	2.03	.27	4.16	7.31	.26	.13	.20
13	.75	.75	.49	10.37	8.30	6.58	9.11	1.95	.27	4.42	7.08	.29	.14	.20
14	.74	.76	.49	10.12	8.31	6.42	8.73	2.01	.27	4.33	7.06	.27	.13	.20

Summary

Table 10, on the next page, is a summary of the more important recommendations for the state as a whole. Cropping systems that will conserve the soil resources require the wider use of rotation pasture, increased acreages of hay, more legumes, less corn, and less small grains. This change in the feed supply would tend to result in fewer hogs and more roughage consuming animals, namely beef cattle, sheep and dairy cows.

Table 10.--Recommended Changes and Comparisons with "Unadjusted" Situation

Item	Unit	Totals for state of Ohio			Percentage changes	
		"Unadjusted" situation (1929)	Recommendations*			
			I**	II**	I	II
1. Total crop land	Acres	11,269,395	10,723,629	10,723,629	- 4.8	- 4.8
2. Rotation pasture	Acres	1,196,894	1,540,314	1,540,314	+28.7	+28.7
3. Woodland pastured	Acres	1,853,703	1,444,190	1,444,190	-22.1	-22.1
4. All other pasture	Acres	4,986,947	5,058,353	5,058,353	+ 1.4	+ 1.4
5. Woodland not pastured	Acres	919,926	1,460,379	1,460,379	+58.7	+58.7
6. All Hay-harvested	Acres	2,625,351	2,904,577	2,904,577	+10.6	+10.6
7. " "-production	Tons	3,660,500	4,215,400	4,492,200	+15.2	+22.7
8. Alfalfa	Acres	190,300	417,000	660,000	+119.	+247.
9. Total feed grains	Acres	4,867,369	3,942,480	3,942,480	-19.0	-19.0
10. Corn-harvested: Total	Acres	3,473,143	2,897,956	2,897,956	-16.6	-16.6
11. Corn, for grain	Acres	3,097,743	2,574,773	2,574,773	-16.9	-16.9
12. Corn-production	Bus.	114,943,000	98,530,000	105,429,000	-14.3	- 8.3
13. Oats-harvested	Acres	1,612,758	1,230,947	1,230,947	-23.7	-23.7
14. Oats-production	Bus.	55,801,400	44,728,000	46,853,000	-19.8	-16.0
15. Wheat-harvested	Acres	1,563,740	1,513,927	1,513,927	- 3.2	- 3.2
16. Wheat-production	Bus.	25,588,800	24,972,000	26,874,000	- 2.4	+ 5.0
17. All small grains	Acres	3,365,706	2,912,823	2,912,823	-13.5	-13.5
18. Soybeans (hay and grain)	Acres	86,642	241,800	241,800	+179.	+179.
19. All cattle***	No.	1,610,000	1,915,390	1,959,120	+19.0	+ 21.7
20. Beef cattle***	No.	235,980	431,460	475,180	+82.8	+101.4
21. Beef produced (beef & dairy)	Cwt.	2,927,705	3,414,975	3,477,471	+16.6	+ 18.8
22. Feeders shipped in	No.	92,000	46,000	36,800	-50.0	-60.0
23. Cows milked***	No.	900,000	972,000	972,000	+ 8.0	+ 8.0
24. Milk produced	Gal.	454,116,752	490,446,100	514,968,300	+ 8.0	+13.4
25. Total swine***	No.	2,078,000	1,927,830	1,986,690	- 7.2	- 4.4
26. Pork produced	Cwt.	7,277,886	6,747,153	6,953,289	- 7.3	- 4.5
27. Total sheep***	No.	2,105,000	2,303,600	2,411,230	+ 9.4	+14.5
28. Mutton produced	Cwt.	857,744	959,803	1,007,486	+11.9	+17.5
29. Chickens raised	No.	32,574,582	32,574,582	32,574,582	-	-
30. Eggs produced	Doz.	135,990,000	135,990,000	135,990,000	-	-
Gross cash income from important products only:						
31. Price Series A	$	177,446,000	173,661,000	182,154,000	- 2.1	+ 2.7
32. Price Series B	$	205,251,000	199,429,000	209,387,000	- 2.8	+ 2.0
Cash income after deducting certain variable cash expenses:						
33. Price Series A	$	161,434,000	158,135,000	166,054,000	- 2.1	+ 2.9
34. Price Series B	$	187,595,000	182,170,000	191,801,000	- 2.9	+ 2.2

* No allowance made for retirement of land from farms.
** I= recommended acreage @ 1936 yields; II= recommended acreages @ 1946 expected yields.
*** Numbers on farms January 1.